



MUNICIPAL SOLID WASTE MANAGEMENT IN THE DEVELOPING WORLD: AN EVIDENCE OF ALIPURDUAR TOWN, WEST BENGAL, INDIA

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Abstract

Alipurduar is one of the growing towns in Northern Bengal in India. The population of the town has increased by 162.24 percent from 1951 to 2011. Therefore, the generation of solid waste has also been increasing. The town generates around 22 tons of solid waste per day at a rate of 269.19 gm per capita per day, which is almost 150.12 gm/day higher than the national average, i.e. 119.07 gm/day. The study aims to highlight the status of solid waste management and to examine the satisfaction level of the residents with the solid waste collection services provided by the Alipurduar municipality. Primary data was collected with the help of a structured questionnaire from 384 sample households distributed in 8 (40 percent) sample wards, and 368 samples were used for data analysis. The results revealed that the existing solid waste management system in Alipurduar municipality is inadequate in terms of solid waste transport vehicles, primary waste collection centres, and dumping grounds. The research also indicated that the appropriate door-to-door solid waste collection is accessible to only 30 percent of the municipality's wards, and 61 percent of respondents are dissatisfied with the existing door-to-door solid waste collection system. The study found that 77 percent of respondents disposed of their garbage in an unscientific way. One-way ANOVA results show that there is a significant difference in mean between the levels of satisfaction except for solid waste collection, environmental change, and burning of solid waste among different income groups. The study suggests that the residents are not satisfied with the service provided by the municipality. Nevertheless, 48 percent of residents are satisfied with the decision to pay money for waste disposal. The study results would help policymakers and bureaucrats devise optimal plans for solid waste management in the city.

Keywords: Urban, Solid Waste Management, Waste Collection, Satisfaction, Environmental Degradation

Introduction

Essentially, "solid waste" refers to waste that has not naturally decomposed over a period of time. Solid waste has been produced since the beginning of civilisation

(Chattopadhyay et al., 2009). It is now a global concern as the generation and mismanagement of waste pose significant environmental and public health challenges (Kaza et al., 2018). Developing countries, in particular, face inadequate solid waste management practices, resulting in environmental pollution, land degradation, and health risks for local communities. The process of rapid industrialisation and population growth in the global south has led to extensive urbanisation, attracting substantial migration from villages to cities. The rate of urbanisation is very high in the developing countries compared to the developed and less developed countries, and people move towards the city for different purposes. Consequently, this influx contributes a significant amount of solid waste to the urban environment and indiscriminate disposal of solid waste. Kaza et al. (2018) underscored the rapid growth of municipal solid waste generation, outpacing the pace of urbanisation. World Bank indicated that by 2025, approximately 4.3 billion urban inhabitants could potentially produce an estimated 1.42 kg/capita/day of municipal solid waste, totalling a staggering 2.2 billion tonnes per day. Due to insufficient financial assistance and infrastructure, many growing cities will fail to manage their solid waste properly. The unmanaged waste creates major health and environmental issues for urban residents (Katusiimeh et al., 2012). Thus, solid waste management has become a critical issue in today's world, especially in developing countries like India (Chattopadhyay et al., 2009; Haque & Talukder, 2021)

As per the UN (World Urbanization Prospectus 2018), India ranks 196 among the world's countries in terms of percentage of urban population. Thus, India can be considered one of the least urbanised countries in the world, with an urban population of only 31.16%. In 2011, the urban population grew to 377 million, which is quite large in absolute number. The United Nations-Habitat's World Cities Report 2022 indicated that India's urban population will reach 675 million in 2035, the second highest behind China's one billion. Keeping pace with the country, the state of West Bengal has also experienced a gradual increase in urbanisation since 1951. In 1951, the percentage of urbanisation in West Bengal was only 23.90, which increased to 31.89 percent in 2011.

In the Himalayan foothill region (Jalpaiguri, Alipurduar and Cooch Behar) of the northern portion of West Bengal, the total population increased by four times, while the total urban population increased by ten times, and the number of urban centres increased by seven times from 1951 to 2011 which is higher than the national level. The urbanisation in the Himalayan foothill region is mainly concentrated in the district headquarters. Alipurduar town is one of the oldest towns in northern West Bengal. It came up along the domestic and international borders (Bhutan and Bangladesh) and the mainland route (rail and road) towards Assam. It belongs to the Class II town category as per the India census. The town's significance has increased after it was designated as a district headquarters on 25th June 2014. Many people from adjacent villages came to Alipurduar town for jobs, medical facilities, and other purposes (Haque & Talukder, 2021). Joardar (2000) highlighted the challenges arising from India's substantial population burden, indicating that efficient management of solid waste remains a significant hurdle.

Mondal and Mandal (2024) also stressed that the amount of rubbish produced in the Class II towns in West Bengal, like Rampurhat municipality, rises dramatically each year along with its population. This issue is further exacerbated in India's tier three or four cities, where municipal financial constraints hinder providing effective waste management services to residents (Roy, 2023). Kumar and Pandit (2013) delved into the reasons behind India's inadequate solid waste management performance. They identified factors such as insufficient financial resources, ineffective institutional structures, inappropriate technological approaches, weak legislative frameworks, and a lack of public awareness as culprits contributing to waste management services' unsatisfactory and inefficient state. Mohanty et al. (2014) reported that the city's primary and secondary waste collection points, as well as its dumping sites, operate in an unscientific manner, exacerbating the challenges associated with waste management.

Solid waste generation has always been related to the socioeconomic status of households. These include monthly income, family size, occupation types, age and education level (Kala et al., 2020). On the other hand, the people in Indian towns like Allahabad, Bilaspur, Raiganj, Bolpur, and Dum Dum are dissatisfied with the municipality's waste management services (Akaateba & Yakubu, 2013; Fetene, 2018; Roy, 2023; Sharholy et al., 2007). Various studies reveal that most households were willing to pay for the safe disposal of the generated solid waste for the betterment of their life (Balasubramanian, 2019; Dhanalakshmi, 2015; Roy & Deb, 2013). It is noted that the income of households, education, size of the household, waste generation quantity and environmental consciousness are the major factors affecting their willingness to pay (WTP) (Hazra et al., 2015; Kala et al., 2020)

The waste management landscape in West Bengal, India, closely resembles other regions in the country. Bhattacharyya (2019) found that the ordinary people of Panihati municipality, North 24 Pargana, of West Bengal, are unaware of how to handle solid waste properly. In the cities of Siliguri and Raiganj, for instance, waste management efforts are hindered by a shortage of both financial resources and technological advancements (Chowdhury, 2018; Haque & Talukder, 2021; Roy, 2023). Haque and Talukder (2021) found a similar tale of mismanagement unfolding in Cooch Bihar, where inadequate solid waste management practices led to evident environmental degradation. They opined that the population of Cooch Behar bears the brunt of this mismanagement, grappling with adverse consequences due to a lack of essential technologies and resources required for effective waste management within the city. Haque and Talukder (2021) sought for the pressing need for improved waste management practices in Cooch Behar to alleviate the hardships endured by its residents and mitigate environmental degradation.

India's per capita solid waste generation (national average) for the last six years has been decreasing (CPCB, 2020-21). As per CPCB, (2020-21), the national per capita solid waste generation rate is 119.07 gm/day. As per the estimation of the Alipurduar Municipality, the town generates around 22 tons of solid waste per day (WBPCB, 2020) at a rate of 269.19 gm per capita per day.

This indicates that the amount of solid waste generated by each individual in the Alipurduar municipality is almost 150.12 gm/day, higher than the national average, i.e. 119.07 gm/day. As a local urban body, the municipality is primarily accountable for solid waste management in Alipurduar. The population load in the town increased, leading to an increase in solid waste generation.

The absence of proper waste management impacts the environment, poses public health risks, and diminishes the overall quality of life in these cities. Urgent attention is required to address these challenges to ensure sustainable and efficient waste management practices for improving life satisfaction and quality of life of vulnerable people from a policy-making perspective. The predominant focus of existing research in the field of municipal solid waste management and planning primarily revolves around three key areas: the characterisation and quantification of solid waste, the identification of appropriate disposal sites, and the optimisation of garbage collection routes, the majority of which have been conducted in metro areas or municipal corporations. In contrast, cities categorised as Class II in India, with populations ranging from 50,000 to 99,999, have received much less attention (Mondal & Mandal, 2024). Therefore, it is essential to know whether the existing infrastructure facilities of small towns like Alipurduar are adequate to serve the residents. Since the residents are the major generators and vulnerable to solid waste, it is also essential to investigate their level of satisfaction with the existing solid waste management system provided by the local urban bodies like municipalities and whether there is a difference in satisfaction about their level of income.

Most of the prior studies, like Chattopadhyay et al. (2009) and Chowdhury & Chowdhury (2020), focused on assessing the status of solid waste management in urban areas. Different studies like Chowdhury, 2018; and Mohanty et al., 2014 used more or less similar criteria to determine the municipality's solid waste management infrastructure. However, the current study aims to expand on these findings by considering the satisfaction level of the municipality's residents regarding the available waste collection services they receive. The present study aims to explore two research inquiries: firstly, it investigates the status of solid waste management within Alipurduar Municipality, and secondly, it assesses the satisfaction level of the municipality's residents with respect to solid waste collection service provided by the Alipurduar Municipality.

Settings of the Study Area

Alipurduar Municipality came into existence under the provision of the Bengal Municipal Act, 1932, on 7 February 1957. Earlier, Alipurduar town was a sub-divisional headquarters in the undivided Jalpaiguri district. On 25th June 2014, the Govt. of West Bengal declared Alipurduar as the 20th district of West Bengal and Alipurduar town was designated as the headquarters of Alipurduar district. Alipurduar Municipality is on the east bank of the river Kaljani, which flows from the northwest to the southeast. The Nonai River bound the eastern side of this town. Geographically, this municipality lies between 26°28'15" N to 26°30'30" N and 89° 31'06" E to 89° 33'14" E (Fig. 1).

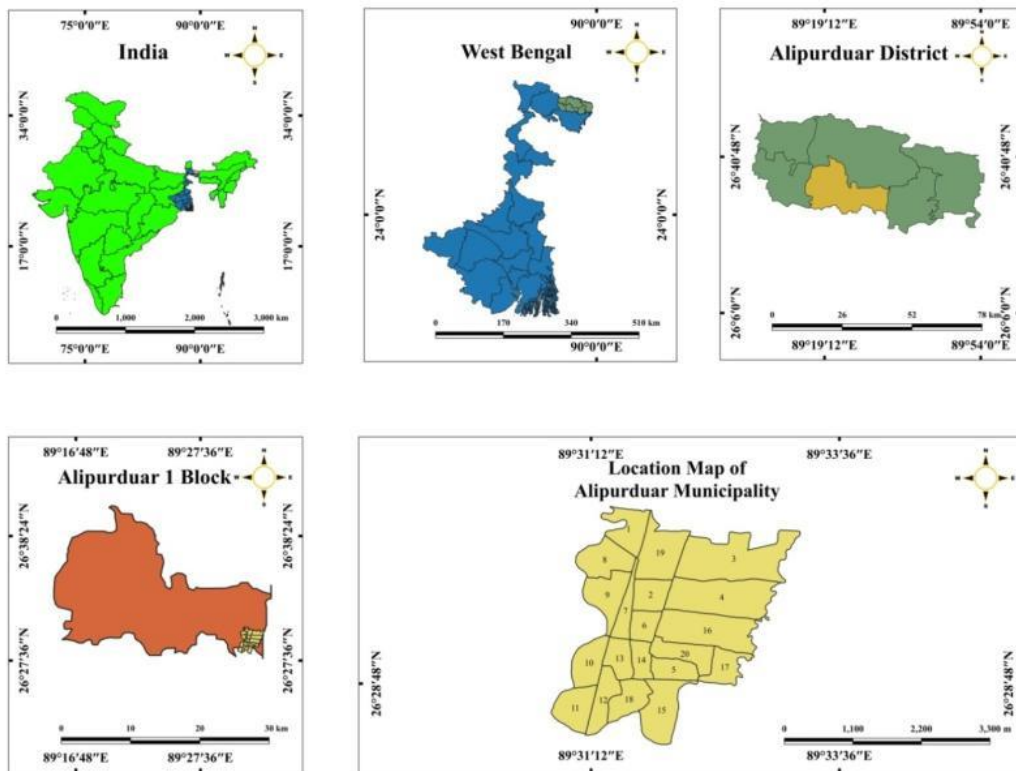


Fig. 1: Location Map of the Alipurduar Municipality

Currently, the municipality is divided into 20 wards covering an area of 8.98 sq. km. with 65232 populations, of which 33137 are male and 32095 are female. The sex ratio is 969 females per thousand males against the state average of 950 females per thousand males. The literacy rate of Alipurduar municipality is 91.03 percent which is higher than the state average of 76.26 percent. The male literacy rate is around 93.34 percent while the female literacy rate is 88.65 percent (Census, 2011). As per the census of India 2011, the population density of Alipurduar municipality is 6071 people per sq. km. The population of Alipurduar Municipality have been increasing since 1951. In 1951, the total population of Alipurduar town was 24886, which increased to 65262 in 2011.

Database

Both secondary and primary data sources were used for the study. The secondary data were collected from the office of the District Magistrate, Alipurduar, Census of India, Alipurduar municipality office and the Ministry of Urban Development of India. On the other hand, a household survey was conducted in March 2023 in Alipurduar municipality with a structured questionnaire from 384 randomly sampled households to collect the primary data. Heads of the households were interviewed face to face as they are the primary

decision-makers of the family and have extensive information on various aspects of their households, including demographics, financial standing, and living arrangements. This position is critical in enabling accurate and consistent data-gathering procedures. In the absence of the head of the household, successive senior members available in the household were interviewed.

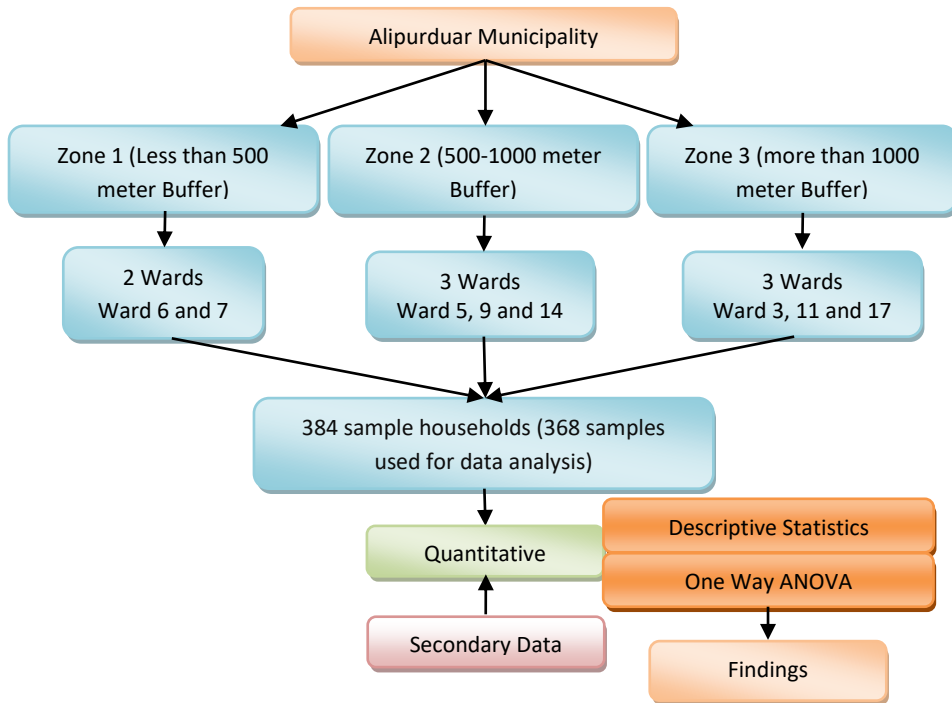


Fig. 2: Flow Diagram of the Study

Sample Design

Alipurduar municipality is formed of 20 municipality wards. As per the pilot study only 7 (30 percent) wards have municipality solid waste management systems in the form of door-to-door solid waste collection. Altogether, eight wards (40 percent) of the Alipurduar were selected for the study, out of which two wards belong to the category having door-to-door municipal solid waste collection system (Fig. 3). To identify the sample wards, a centroid was drawn on the municipality ward map of Alipurduar in QGIS environment as a geographical centre of the town. From the centroid of the Alipurduar Municipality, 500-metre and 1000-metre buffers were created. Sample wards were selected purposively based on the following conditions. Firstly, the number of wards will be proportionate to the percentage of wards having and without having door-to-door solid waste collection services. Secondly, the maximum covered wards within each buffer zone will be selected, maintaining the maximum possible cardinal direction.

Within the 500-metre buffer, two wards, namely wards 6 and 7, were selected as most of the wards are covered by the zone. Within the 1000 metre buffer, most of the wards 20, 5, 14, 13 and 9 were covered. Fifty percent of wards within this zone (Ward 5, 14 and 9) following the cardinal direction were selected. On the other hand, 11 wards, namely 1, 3, 8, 19, 4, 17, 18, 15, 12, 11 and 10, have most of the area beyond the 1000-metre buffer zone. The remaining three wards (Ward 3, 17 and 11) from each cardinal direction of this zone were selected for the study (Fig. 2 and Fig. 3).

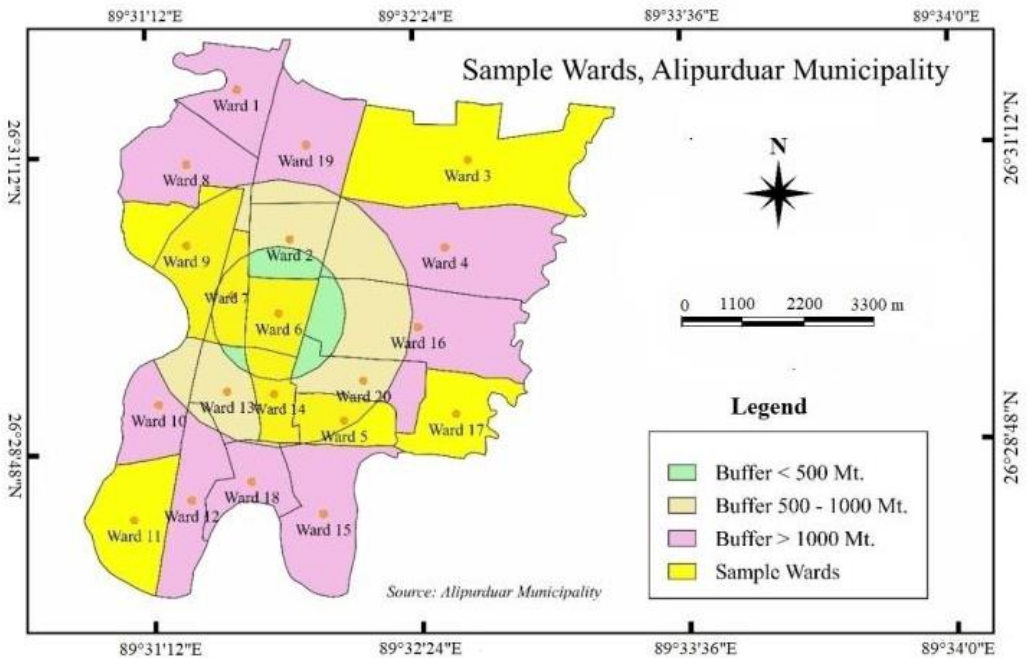


Fig. 3: Distribution of Sample Wards of Alipurduar Municipality

A sample size of 384 households was determined using the Cochran formula (1977) with a confidence level of 95 percent and 5 percent plus or minus precision. The sample households were distributed equally among all people wards and executed randomly.

$$\text{Sample size calculation } n_o = \frac{Z^2(pq)}{e^2}$$

Where,

n= Sample Size

Z= Standard Error associated with the chosen level of confidence

P= Variability/Standard Deviation

q= 1-p

e= Acceptable sample error

Statistical Analysis

A modified version of the structured questionnaire was adopted from Akaateba and Yakubu (2013) to measure the respondent's satisfaction level with the waste collection services provided by the municipality. A set of 12 questions related to the aspects of the solid waste management services provided by local urban bodies has been prepared based on the literature review and insights acquired from the field visits (Table 1). Respondents were asked to assess the extent to which they were satisfied with the services given by the municipality of Alipurduar. The responses for each statement in the questionnaire were scored on a five-point Likert scale ranging from 'very satisfied' to 'very dissatisfied'. The values were entered as 5 = very satisfied to 1 = very dissatisfied. In addition, the questionnaire included a part that collected data on socio-demographic and economic data, as well as garbage collection and disposal techniques. Age, gender, educational level, marital status, income level, garbage collection bin condition, and waste collection frequency were included as explanatory variables based on a literature review.

Initially, the questionnaire was pre-tested to determine its reliability using Cronbach's alpha in IBM SPSS Statistics 22. The internal consistency of the questionnaire was demonstrated by Chronbach's alpha value of reliability 0.753 (>0.7 is considered satisfactory). Due to the lack of a complete dataset, 16 questionnaires have been removed, and 368 samples have been used for the data analysis. Descriptive statistical techniques have been applied to analyse the data. The higher mean indicates a higher degree of satisfaction, and the variables are ranked accordingly. A mean score of less than 3 indicates a higher degree of dissatisfaction, a mean of 3 to 3.50 shows a moderate level of satisfaction, and a mean of more than 3.50 indicates a high level of satisfaction (Akaateba & Yakubu, 2013). Lower values in the rank indicate a higher level of satisfaction. As a significant controlling factor, the average monthly income of any household may be considered a proxy measure of socio-economic status and standard of living, resulting in variations in the generation and disposal of solid waste. Higher-income households have a more significant contribution to solid waste production. Furthermore, these higher-income households can manage their solid waste privately by being willing to pay for solid waste management. Consequently, the level of satisfaction with different aspects of municipal solid waste management will be different among various income groups. A one-way ANOVA was employed in this study to evaluate any differences in mean household satisfaction and income level. The P value of 0.05 is considered statistically significant.

Results

Socio-Economic and Demographic Characteristics of Respondents

There are 55.40 percent males and 44.30 percent females among the 368 total respondents. Most respondents (36.10 percent) are between the ages of 30 and 45. On the other hand, 32.10 percent of respondents are between the ages of 45 and 60. 15.5 percent of respondents are between the ages of 15 and 30, while 16 percent are between the ages of 60 and above. The survey reveals that the majority of respondents in this survey are

graduates (28.8 percent). Respondents with secondary and higher secondary levels of education account for 16.6 percent in each category. 13.3 percent of respondents completed their education to the upper primary level and 11.4 percent completed their education to the elementary level. Only 9.2 percent of respondents in the studied population have a postgraduate degree, while 3.8 percent of respondents are illiterate.

Table 1: Questions for Satisfaction Survey*

Question No	Statement: To what extent are you satisfied with the following Statement	Reference
1	Are you satisfied with the Alipurduar Municipal Council's waste collection vehicles?	(Shriwas et al., 2018)
2	Are you satisfied with the behaviour of the waste collection crew towards your residence?	(Shriwas et al., 2018)
3	Are you satisfied with the waste collection containers supplied by the Alipurduar Municipal Council?	(Fetene, 2018)
4	Are you satisfied with the availability of dustbins provided by the Alipurduar Municipality Council's Waste Collection?	(Fetene, 2018)
5	Are you satisfied with the Alipurduar Municipal Council's dumping collected solid waste procedure?	(Shriwas et al., 2018)
6	Are you satisfied with the door-to-door solid waste collection status in your neighbourhood?	(Chowdhury & Chowdhury, 2020)
7	Are you happy with your neighbourhood's garbage disposal system?	(Shriwas et al., 2018)
8	To what extent are you satisfied with the quality of the environment in Alipurduar compared to the environment five years ago?	(Rajkumar, 2015)
9	Are you pleased with the public garbage dumpsters' condition near your residence?	(Akaateba & Yakubu, 2013)
10	Are you satisfied with the frequency of public waste bin cleaning in your locality?	(Fetene, 2018; Sharholy et al., 2007; Shriwas et al., 2018)
11	How satisfied are you with the solid waste burning in your area?	(Nikhanj & Mishra, 2014)
12	Are you satisfied with the decision to pay for solid waste disposal?	(Afroz et al., 2009)

**Each question was coded as 5 = Very Satisfied; 4 = Satisfied; 3 = Neutral; 2 = Dissatisfied; 1= Very Dissatisfied*

Table 2 highlights that a large number of respondents in the study area collect their waste materials in the 'old bucket' (49.2 percent) whereas 27.2 percent use cardboard containers. Only 8.7 percent of respondents utilise municipally provided garbage collection containers to gather waste, and 6.8 percent use tins or cans. Furthermore, 8.2 percent of respondents did not have a waste container and hence dropped it in the open field.

Table 2: Description of Study Participants about the Garbage Collecting Bins and Disposal of Solid Waste (N= 368)

Variables	Categories	Frequency	Percent
Type of container used to collect waste materials	Cardboard Container	100	27.2
	Old Bucket	181	49.20
	Tin/Can	25	6.8
	Municipality Bins	32	8.7
	Open Detach in the household premises	30	8.2
Place to put away collected wastes	In the Public Bin	42	11.40
	By the Road or street side	185	50.30
	On an Open Space	94	25.5
	Municipality Vans	42	11.4
	By the River	5	1.4

Source: Field Survey, 2023

To answer the question "Where do you usually put your collected waste?" half of the respondents (50.30 percent) admitted that they dump their collected waste materials on the road and street sides. Only 11.4 percent of respondents said they take their trash to municipal vehicles. 25.5 percent of the population disposed of their garbage in open space. 11.4 percent of respondents dispose of their domestic garbage in public containers, while 1.4 percent disposes of their generated waste in river water. Altogether 77.2 percent respondents disposed off their garbage in an unscientific way (Table 2).

Solid Waste Management Infrastructure in the Alipurduar Municipality

In Alipurduar municipality, only seven wards (out of 20) have door-to-door waste collection facilities (Table 3), and the residents of the remaining wards are disposed of openly by roads or river water. Only 58 primary and one secondary waste collection point are in operation to serve the municipality. Moreover, there is no permanent landfill site in the study area for the proper disposition of solid waste. Out of 20 municipal wards, only seven households were provided solid waste collection bins. The municipality has only 33 trolleys and 12 battery-powered trippers, insufficient to cover all 20 wards (Table 3).

Satisfaction Level of the Residence of the Alipurduar Municipality

Considering the current state of solid waste management in the developing world, it is essential to investigate the quality of solid waste management in the municipality (Akaateba & Yakubu, 2013). Table 4 depicts the quality of waste collection services provided by the Alipurduar municipality by examining the level of satisfaction of the households with the service provided by municipalities.

Table 3: Present Solid Waste Management Infrastructure in the Alipurduar Municipality

Criteria	Availability
Door-to-Door Waste Collection	7 Wards
Waste Collection	7 wards with 33 trolleys, 12 battery-operated trippers, and available PPEs is 50
Waste Transport Point	58 primary waste transfer points and 1 secondary waste transfer point.
Waste Transport Vehicles	Tricycle Van: 33, Trucks: 02, Mini Truck: 01, Tractor: 06, Mini Dumper: 02, Dumper Placer: 01, Battery Operated Tripper: 14
Landfill Site	Not Available
Segregation and Recycle/ Reuse	MRF facility exists and is working where segregation of all types of dry waste is done. The segregated dry wastes are regularly handed over to a vendor against the highest market price. Set-up for energy
<i>Source Alipurduar Municipality, 2023</i>	

The study shows that the majority of the respondents are 'very dissatisfied' in case of their satisfaction level with the waste collection vehicles (35.3 percent), the behaviour of the waste collection crews (31 percent), waste collection containers (37.8 percent), dustbins provided (39.7 percent), the procedure for dumping (37.5 percent), quality of the public dumpers (33.4 percent), frequency of the waste bins cleaning (28.8 percent) and burning of solid waste in the localities (32.3 percent). It was found that the highest percentage of respondents (39.4 percent) is dissatisfied with the status of the municipality's door-to-door solid waste collection procedure. The highest percentage of respondents (40.5 percent) is basically 'neither satisfied nor dissatisfied' to the extent of the quality of the environment in Alipurduar as compared to the environment five years ago. Altogether, 48.7 percent of households are satisfied with their neighbourhoods' garbage disposal system. Besides, it is interesting to note that 48.1 percent of households are 'satisfied' with the decision to pay nominal charges for solid waste disposal.

Respondent's Satisfaction by Income Level

Table 5 depicts the effect of householder's income level on satisfaction with various waste managementservices of Alipurduarmunicipality. The analysis (p-value less than

0.05 considered as significant) indicates that there was a statistically significant difference in mean household income and satisfaction with service component regarding waste collection vehicles ($F= 3.11$, $P= 0.015$), behaviour of the trash collection crew ($F= 3.86$, $P=0.004$), waste collection container supplied by the municipality ($F= 3.84$, $P= 0.005$) dustbins provided by the municipality ($F= 5.52$, $P= 0.000$) waste dumping process ($F=5.019$, $P= 0.001$), neighbourhood garbage disposal system ($F=2.15$, $p=0.074$), quality of public bins ($F=6.685$, $P=0.000$), frequency of public waste bin cleaning ($F=3.24$, $P=0.012$) and satisfied with the decision to pay for the disposal of solid waste ($F=3.001$, $P=0.019$). On the other hand, in case of satisfaction with door-to-door waste collection ($F= 1.055$, $P= 0.379$), quality of the environment in Alipurduar as compared to the environment five years ago ($F=3.27$, $p=0.12$), and solid waste burning issue in the area ($F=1.61$, $p=0.154$) we do not have sufficient evidence to conclude that there is a statistically significant difference between the means of the income and household satisfaction.

Discussion

In Alipurduar town, solid waste management is primarily the responsibility of the municipality as it is the local urban body. Most of the municipal wards have yet to install door-to-door solid waste collection systems. Besides, the study reveals that the infrastructural facilities required for a healthy and efficient solid waste management system in a class II town like Alipurduar are inadequate. The findings of the studies conducted in the context of class II towns of Northern Bengal like Cooch Behar, Jalpaiguri (Chowdhury & Chowdhury, 2020), and Raiganj (Roy, 2023) also highlights similar results. Shriwas et al. (2018) also found the inadequacy in solid waste management infrastructural facilities in class I towns like Bilaspur and Raipur in Chattisgarh. Thus, a Class I town may have a larger population and potentially more resources; it does not automatically mean that its waste management practices are better than those in a Class II town.

Inadequate infrastructural facilities and shortage of manpower in the towns of developing countries like India caused a heavy workload on the municipality's trash collectors, impacting their behavioural instability. This is probably why the respondents expressed extreme dissatisfaction with the driver's (trash collector's) behaviours. Infrequent and irregular door-to-door solid waste collection schedules may be another reason for dissatisfaction. Due to insufficient dustbins, the residents collect their waste materials in old buckets without segregation. The absence of door-to-door solid waste collection services in most wards compelled the residents to put away their waste materials along the roads or street sides, in open spaces and on the river. Notably, the results of this study indicate a prevailing sense of discontent among the municipality's inhabitants, with many expressing significant dissatisfaction with the services provided by the Alipurduar municipality as a local authority. Interestingly, many residents are happy and neutral with the neighbourhood's garbage disposal system. It is also reflected in their neutrality and satisfaction with the environmental changes in Alipurduar town.

Table 4: Measures of Satisfaction Level of the Respondents in Alipurduar Municipality

Statement: To what extent are you satisfied with the following Statement	Very Satisfied n (%)	Satisfied n (%)	Neither satisfied nor dissatisfied n (%)	Dissatisfied n (%)	Very dissatisfied n (%)
Are you satisfied with the Alipurduar Municipal Council's waste collection vehicles?	45 (12.2)	71 (19.3)	53 (14.4)	69 (18.8)	130 (35.3)
Are you satisfied with the behaviour of the waste collection crew towards your residence?	32 (8.7)	67 (18.2)	108 (29.3)	47 (12.8)	114 (31.0)
Are you satisfied with the waste collection containers supplied by the Alipurduar Municipal Council?	23 (6.3)	41 (11.1)	94 (25.5)	70 (19.0)	139 (37.8)
Are you satisfied with the availability of dustbins provided by the Alipurduar Municipality Council's Waste Collection	23 (6.3)	67 (18.2)	48 (13.0)	84 (22.8)	146 (39.7)
Are you satisfied with the Alipurduar Municipal Council's procedure for dumping collected solid waste?	31 (8.4)	63 (17.1)	72 (19.6)	63 (17.1)	138 (37.5)
Are you satisfied with the status of door-to-door solid waste collection in your neighbourhood?	19 (5.2)	68 (18.5)	56 (15.2)	145 (39.4)	80 (21.7)
Are you happy with your neighbourhood's garbage disposal system?	68 (18.5)	111 (30.2)	122 (33.2)	30 (8.2)	37 (10.1)
To what extent are you satisfied with the quality of the environment in Alipurduar as compared to the environment five years ago?	25 (6.8)	84 (22.8)	149 (40.5)	58 (15.8)	52 (14.1)
Are you pleased with the condition of the public garbage dumpers near your place of residence?	10 (2.7)	65 (17.7)	49 (13.3)	121 (32.9)	123 (33.4)
Are you satisfied with the frequency of public waste bin cleaning in your locality?	43 (11.7)	60 (16.3)	76 (20.7)	83 (22.6)	106 (28.8)
How satisfied are you with the solid waste burning in your area?	43 (11.7)	63 (17.1)	58 (15.8)	85 (23.1)	119 (32.3)
Are you satisfied with the decision to pay for solid waste disposal?	58 (15.8)	119 (32.3)	90 (24.5)	82 (22.3)	19 (5.2)

Source: Field Survey, 2023

Table 5 Results of One-Way ANOVA Analysis between Income Level and Household Satisfaction

Statement	Average Monthly Income level in Thousand Indian Rupees					F
	>5	5 -10	10 -15	15 -20	<20	
Are you satisfied with the Alipurduar Municipal Council's waste collection vehicles?	3.04	2.91	2.58	2.40	2.41	3.11*
Are you satisfied with the behaviour of the waste collection crew towards your residence?	2.99	2.64	2.74	2.58	2.27	3.86**
Are you satisfied with the waste collection containers supplied by the Alipurduar Municipal Council?	3.01	2.69	2.45	2.73	2.17	3.84**
Are you satisfied with the availability of dustbins provided by the Alipurduar Municipality Council's Waste Collection	3.00	2.75	2.75	2.31	1.96	5.52**
Are you satisfied with the Alipurduar Municipal Council's procedure for dumping collected solid waste?	2.96	2.92	2.71	2.33	1.63	5.01**
Are you satisfied with the status of door-to-door solid waste collection in your neighbourhood?	3.00	2.93	2.75	2.57	2.66	1.05
Are you happy with your neighbourhood's garbage disposal system?	3.02	2.78	2.77	2.58	2.16	2.15**
To what extent are you satisfied with the quality of the environment in Alipurduar as compared to the environment five years ago?	2.84	2.72	3.08	2.28	2.40	3.27
Are you pleased with the condition of the public garbage dumpsters near your place of residence?	3.07	2.65	2.66	2.87	1.91	6.68**
Are you satisfied with the frequency of public waste bin cleaning in your locality?	2.07	2.79	2.72	2.87	2.83	3.24*
How satisfied are you with the solid waste burning in your area?	2.76	2.64	2.89	2.55	3.29	1.61
Are you satisfied with the decision to pay for solid waste disposal?	2.53	2.33	2.74	2.87	2.98	3.00**

p-value less than 0.05 consider as significant; **p*<0.05; ***p*<0.01

Source: Field Survey, 2023

The findings of the present study are contrasting with the findings of the study where Katusimeh et al. (2012) reported that the respondents are satisfied with the frequency of services provided by the municipality. However, this study found that most respondents are very dissatisfied with the frequency of services, the quality of garbage collection bins and the number of bins provided by the municipality. One of the primary sources of discontent is with the primary waste collection stations, where wastes are piled for several weeks without being removed. The rubbish mounds generate a foul odour, which is hazardous to one's health and the environment (Mohanty et al., 2014). The respondents are extremely dissatisfied with the municipality's garbage disposal techniques, as no suitable disposal site exists. Overall, respondents were mostly dissatisfied with the municipality's expected role with the existing door-to-door solid waste collection system in the town. This reflects on the level of satisfaction of the residents with the solid waste management services provided by the local urban body in Indian towns like Shilchar (Roy, 2023) and Allahabad (Sharholy et al. (2007), Chinese towns like Harbin, and African towns like Ghana (Akaateba & Yakubu, 2013), Jimma city of South East Ethiopia (Fetene, 2018).

Studies conducted in Indian towns like Shilchar (Roy & Deb, 2013), Kolkata (Hazra et al., 2015), Madurai (Balasubramanian, 2019), Alappuzha (Dhanalakshmi, 2015) and African towns like Ghana (Akaateba & Yakubu, 2013) have highlighted the fact that residents in municipalities often contribute financially to ensure smooth waste disposal within the city. Our study highlights noteworthy findings wherein respondents express satisfaction with the decision to pay for door-to-door waste collection services. This also suggests an intense desire among the people in Alipurduar municipality to promptly address their waste disposal concerns, which is influenced by their economic strength.

Jha et al. (2011) found that solid waste management practices vary significantly across different income groups. In this study, we found that the residents of various income groups share a similar level of satisfaction on the issues of door-to-door solid waste collection, environmental change in the town, and burning of solid waste. Perhaps this results from the nature of the issues, as the household's financial investment does not influence these general problems. Furthermore, these issues consistently impact households across various income groups. On the other hand, specific issues like the quality of waste collection vehicles, behaviour of the trash collection crew, waste collection containers provided by the municipality, dust bins provided, waste dumping process, neighbourhood's garbage disposal system, quality of public bins, and the frequency of cleaning public waste bins are perceived differently by respondents of various income groups due to their differential economic strength and standard of living. This is also evident in the respondents' decisions to pay for solid waste disposal.

Conclusion

The primary goal of this article is to examine the degree of satisfaction of the residents with the available municipality solid waste management system. In Alipurduar town, the infrastructure or services related to solid waste management have not kept pace

with the population growth, creating a potential issue or challenge. Besides, the available services could not reach to the citizens of the municipality adequately due to a lack of technological and muscular strength. The research also indicated that the appropriate door-to-door solid waste collection is inaccessible to the municipality's wards. The lack of required services compelled the residents to put their collected solid waste material away in open spaces, roadsides and rivers. Overall, the findings of this investigation indicate that the respondents are "very dissatisfied" with the available municipal solid waste management systems in the town.

As a local urban body, the Municipality should implement the door-to-door solid waste collection system in all wards. The municipality should establish an appropriate waste disposal ground. Besides, the number of human resources and collector vehicles involved in door-to-door collection should be increased proportionately to the number of wards. Waste collection frequencies and primary waste collection points should be increased, keeping parity with the demand. Every household should provide two waste collection bins to segregate the generated waste materials primarily. Nevertheless, the municipality has to take serious initiatives to spread awareness among the residents about segregation and effectively dispose of the created garbage. The study revealed a strong desire among the people in Alipurduar municipality to promptly address their waste disposal concerns, with satisfaction in the decision to pay money for waste disposal. The taxation for improving the proper solid waste management services may be implemented considering the layers in the income groups. Residents of Alipurduar municipality may be more satisfied if the municipality's waste management system is improved with the improved infrastructural facilities covering all the municipal wards.

Competing Interests and Funding

The authors have no conflicts of interest to disclose. No funding was received for this study.

Availability of Data and Materials

The data that supports the findings of this study is mainly primary data obtained from the household survey using face-to-face interview techniques. The data is related to the satisfaction of the residents of Alipurduar Municipality with municipal solid waste management. The data also includes the socio-economic and demographic status of households. The data were collected from the respondents, assuring them that the privacy of their data would be maintained in strict confidence. The collected data and other information will be used for purely academic purposes. However, the data is available from the authors upon reasonable request and with the permission of the respondents from whom the data was collected.

Author's contributions

BK collected data, undertook statistical analyses, prepared and edited the manuscript; DS designed the study, and edited the manuscript.

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